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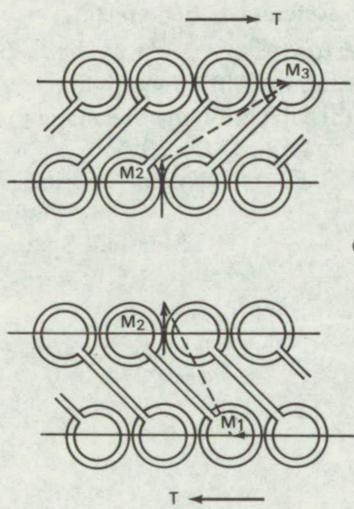
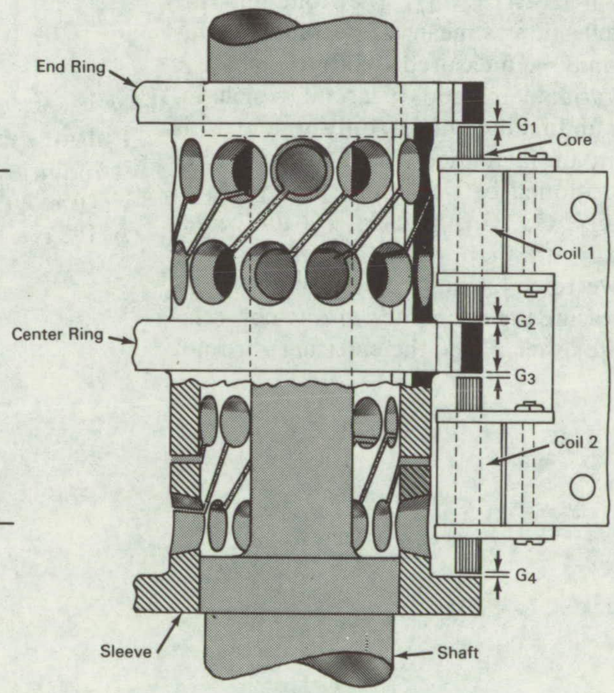
Brief 66-10048

NASA TECH BRIEF

Noncontacting Transducer Measures Shaft Torque





The problem:

To design a transducer system using a noncontacting pickup to measure the output torque of a rotating shaft.

The solution:

Use a specially designed sleeve of magnetically permeable material that fits snugly over a small section of the shaft and deflects axially in direct proportion to the output torque of the rotating shaft. Stationary inductance pickup coils mounted in close proximity to, but not in contact with, the sleeve undergo a corresponding change in reluctance, which is measured by conventional circuitry connected to the pickup coils.

How it's done:

A small section of the shaft is reduced in diameter in order to ensure a relatively large torsional deflection between the two end portions of the shaft when

(continued overleaf)

torque is applied. The sleeve of magnetically permeable material is symmetrically positioned over the reduced section and secured by a shrink fit to the ends of the full-diameter shaft adjacent to the reduced section. The sleeve incorporates three integral rings, one at each end and one at the midsection. Two circumferential bands of equidistant holes are radially drilled through each portion of the sleeve between the central ring and the end rings. The holes in each pair of bands are connected by slots cut at an angle of 45° with respect to the shaft axis. The slots in one portion of the reduced section are at 90° to the slots in the other portion. The sleeve constructed in this manner has a much smaller torsional stiffness than the shaft.

When torque is applied to the shaft as indicated by T-T, the end rings will deflect in an axial direction, as indicated by M_2. Since for small deflections, $M_1 = M_2 = M_3$, axial deflection of the center ring, M_2, will be equal to $M_1+M_3/2$ (i.e., one-half the total torsional deflection at mean sleeve radius). This axial deflection may be measured (while the shaft is rotating) by a variable reluctance circuit which incorporates four inductance coils (only one pair is illustrated) wound on laminated cores. A pair of coil assemblies is positioned between the rings to form small air gaps, G_1, G_2, G_3, and G_4. As the center ring moves axially, the gap width G_2 increases or decreases relative to G_3, thus correspondingly increasing or decreasing the reluctance of one coil relative to that of the other. Since the end rings are not deflected axially, G_1 and G_4 remain constant and do not affect the reluctance of the coils. When the two pairs of coils are connected in an ac Wheatstone bridge circuit, the output signal amplitude will be proportional to the deflection or shaft torque.

Notes:

1. This transducer system operates equally well at all shaft speeds and therefore may be calibrated statically.
2. Since no electrical or frictional contact is made with the rotating shaft, the system would be especially useful for measuring torque at high rotational speeds.
3. The effect of slight axial or radial movement of the coil assemblies is cancelled by the symmetrical design of the system.
4. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama, 35812
   Reference: B66-10048

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code AGP, Washington, D.C., 20546.

Source: North American Aviation, Inc.
under contract to
Marshall Space Flight Center
(M-FS-474)